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Information & Electronic Warfare Systems Overview

LOW COST PRECISION KILL (LCPK)

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Agenda

- **LCPK/APKWS History**
- **Mid-Body Guidance and Control Section**
- **Guidance and Control Electronics**
- **Distributed Aperture Semi-Active Laser Seeker (DASALS)**
- **LCPK Technology**
  - **Demo'd TRL 6 in Sept 2002**
- **Predicted Weapon System Performance**
- **Conclusion**

BAE SYSTEMS Distributed Aperture SAL Seeker (DASALS) Technology enables Affordable Precision Upgrades to Existing Weapon Systems

Background

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- **Dec 89 - US Army stated the need for a guided rocket program**
  - "You could fire that Hellfire through a window four miles away at night."
    -- Lt Gen Carl Stiner, XVIII Airborne Corps Commander
  - OPERATION JUST CAUSE highlighted the need for a lightweight, low-cost precision weapon against soft targets in urban terrain
- **Feb 96 - APKWS Mission Needs Statement signed**
- **Mar 00 - APKWS Operational Requirements Document signed**
- **Low-Cost Precision Kill (LCPK) ATD (Advanced Technology Demonstration) sponsored by the Aviation and Missile RDEC from 1996-2002**
  - BAE SYSTEMS and Raytheon selected as LCPK developers

- **APKWS funded in 2001 with program responsibility passed to PM Aviation Rockets & Missiles in 2002**

  - **General Dynamics chosen as sole source integrator for APKWS - contract award Feb 03**

GENERAL DYNAMICS
Armament and Technical Products

  - **BAE Systems and Raytheon competed for APKWS seeker - Seeker Award Feb 03**

BAE SYSTEMS' Distributed Aperture Semi-Activity Laser Seeker (DASALS)

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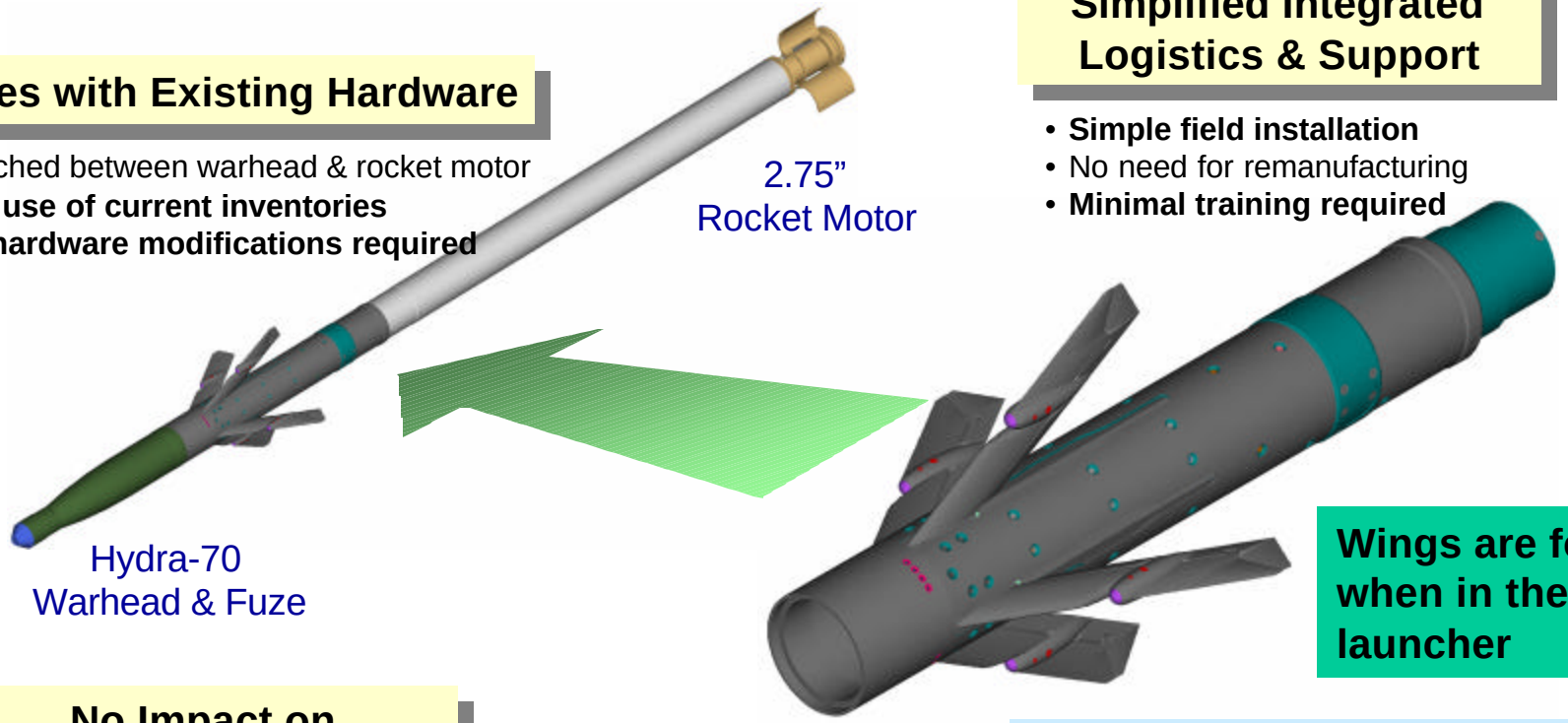
DASALS allows for a Mid-Body LCPK Guidance System

Mates with Existing Hardware

- Attached between warhead & rocket motor
- **Full use of current inventories**
- **No hardware modifications required**

Simplified Integrated Logistics & Support

- **Simple field installation**
- No need for remanufacturing
- **Minimal training required**



Wings are folded when in the launcher

No Impact on Warhead Effectiveness

Plug & Play Kit Provides Maximum Flexibility

BAE SYSTEMS’ self-contained guidance and control system converts unguided 2.75" rockets into low cost guided rockets.

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Designed to Support the Warfighter

Precision Attack, Low Cost Alternative complements the HELLFIRE and Common Missile

Proportional Navigation

Uses existing Hydra-70
- **Launchers**
- **Fire Control System**
- **Rocket Motors**
- **Warheads**

Uses existing Laser Designators:
Air (HELLFIRE) or Ground-Based

Soft or Lightly Armored Target

Plug-and-Play concept minimizes impact:
- On pilot training
- On weapons loading procedures

Mid-body design provides the flexibility to use any Hydra-70 warhead and fuze

Robust design protects seeker against:
- Adjacent weapon firings
- Sand, dust, and moisture

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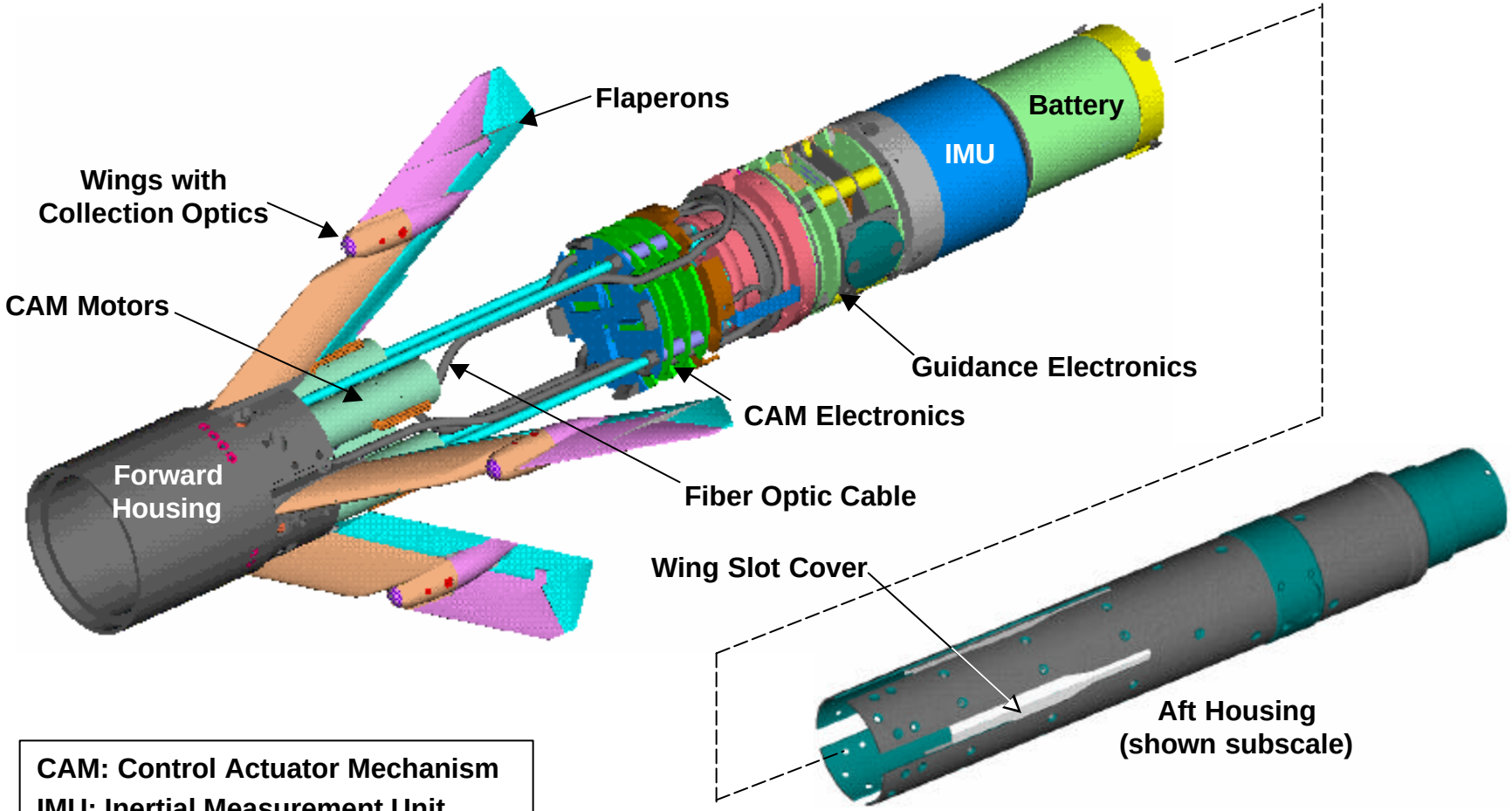
DASALS Guidance Assembly for the LCPK



CAM: Control Actuator Mechanism
IMU: Inertial Measurement Unit

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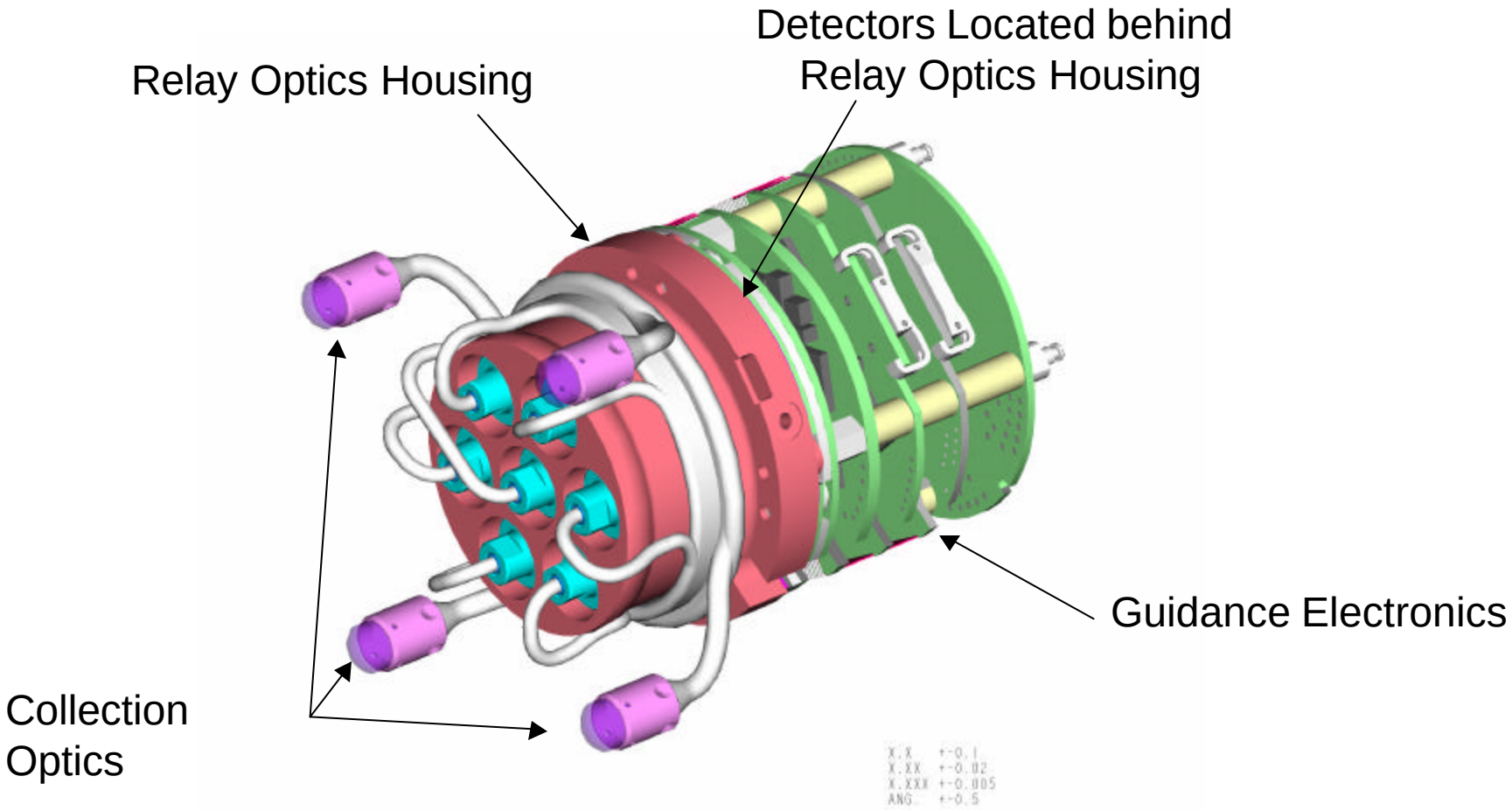
Distributed Aperture Semi-Active Seeker (DASALS) Design



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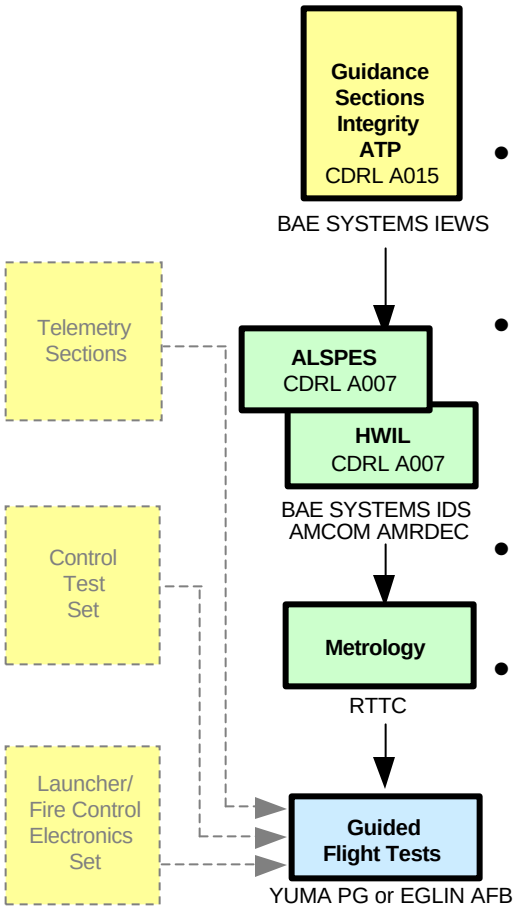
LCPK Pre-Flight Lab Test Summary



- **Integrity (Temp / Shock / Vib)**
  - **BAE SYSTEMS IEWS, Nashua NH**
- **ALSPES (selected units, before AMRDEC HWIL)**
  - **AMRDEC, Huntsville AL**
- **HWIL**
  - **BAE SYSTEMS IDS, Austin TX**
  - **AMRDEC, Huntsville AL**
- **Metrology**
  - **Yuma PG, Yuma AZ**
- **Guided rocket checkout**
  - **Verify CTS interconnects & Telemetry (end-to-end)**
  - **Pre-power Rocket to verify guidance electronics**

Comprehensive, methodical, Government-witnessed pre-test sequence before committing to ATD launch

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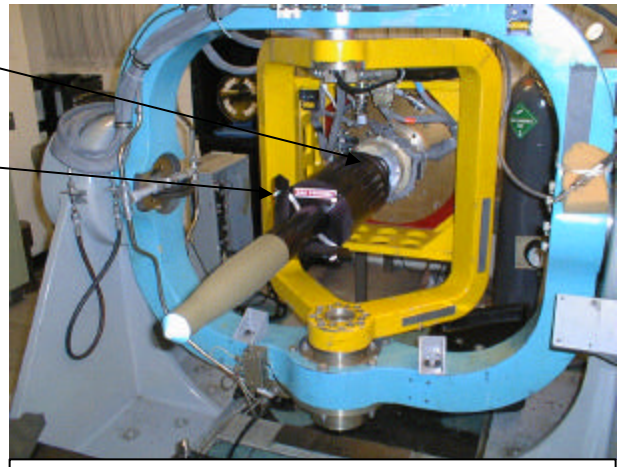
LCPK HWIL Test Summary Table

Test Chronology

Milestone	Date
6-DOF software install and I/F check	11-15 Jun 2001
Closed loop on CAM and IMU	9-13 Jul 2001
Seeker integration	6-10 Aug 2001
G&C tuning	13-17 Aug 2001
G&C tuning	20-24 Aug 2001
6-DOF validation runs	4-7 Sep 2001



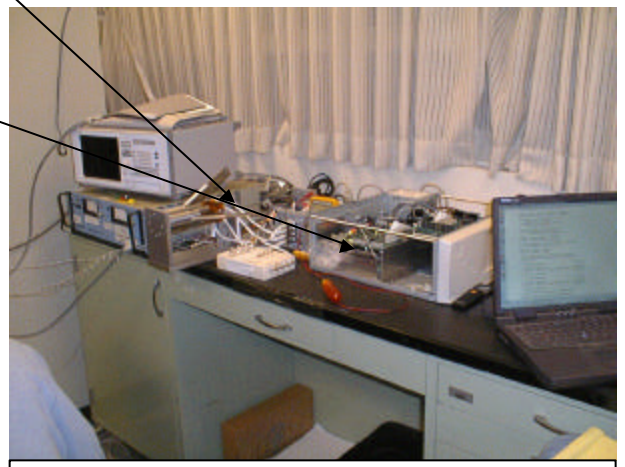
Warhead, Seeker, & IMU on Flight Table

LCPK Configuration

Brassboard hardware was used. Seeker, IMU, & dummy warhead were mounted on the flight table.

Guidance electronics & CAM were on a bench.

- 6” diameter canister housed the seeker electronics and IMU.
- Fixed block wings housed the four optical lenses.



CAM & Guidance Electronics on Bench

Final HWIL System Integration and Test of LCPK Guidance Sections

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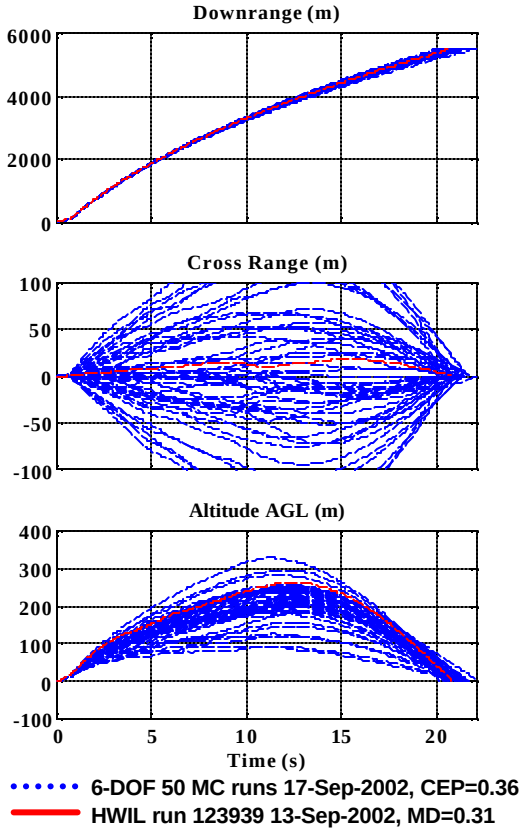
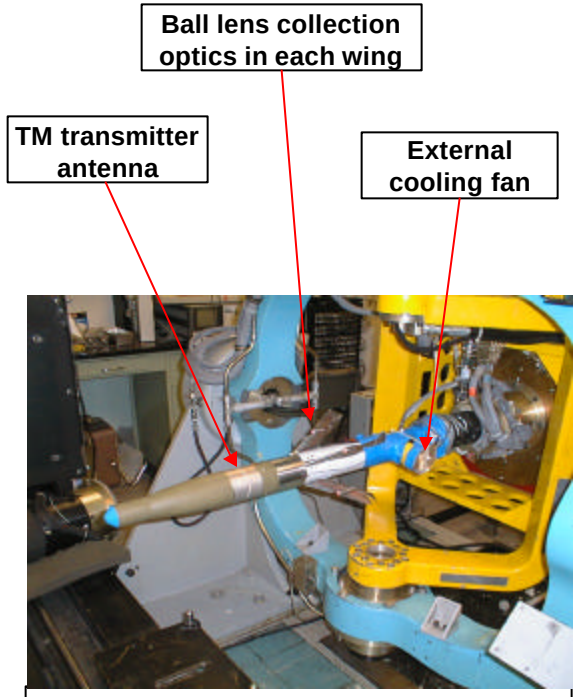
- HWIL simulation verification and validation
- Final test of flight hardware and software prior to actual flight test
- The HWIL test process “caught” several problems saving potential flight test failures
- Flight scenarios had to perform successfully in the lab before releasing to the flight test team
- All test objectives were successfully completed





TM Warhead & GS on Flight Table

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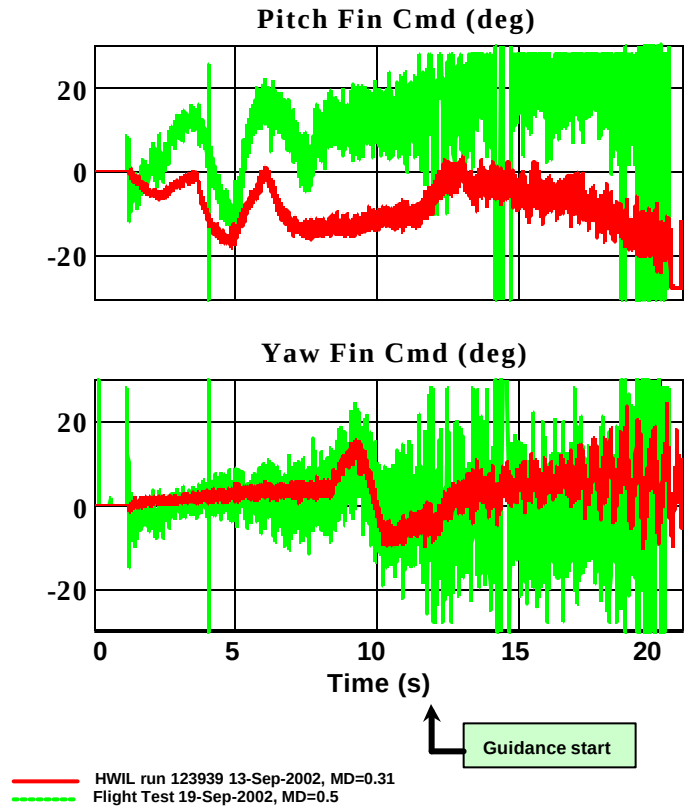
HWIL and **THE SHOT** - Great correlation



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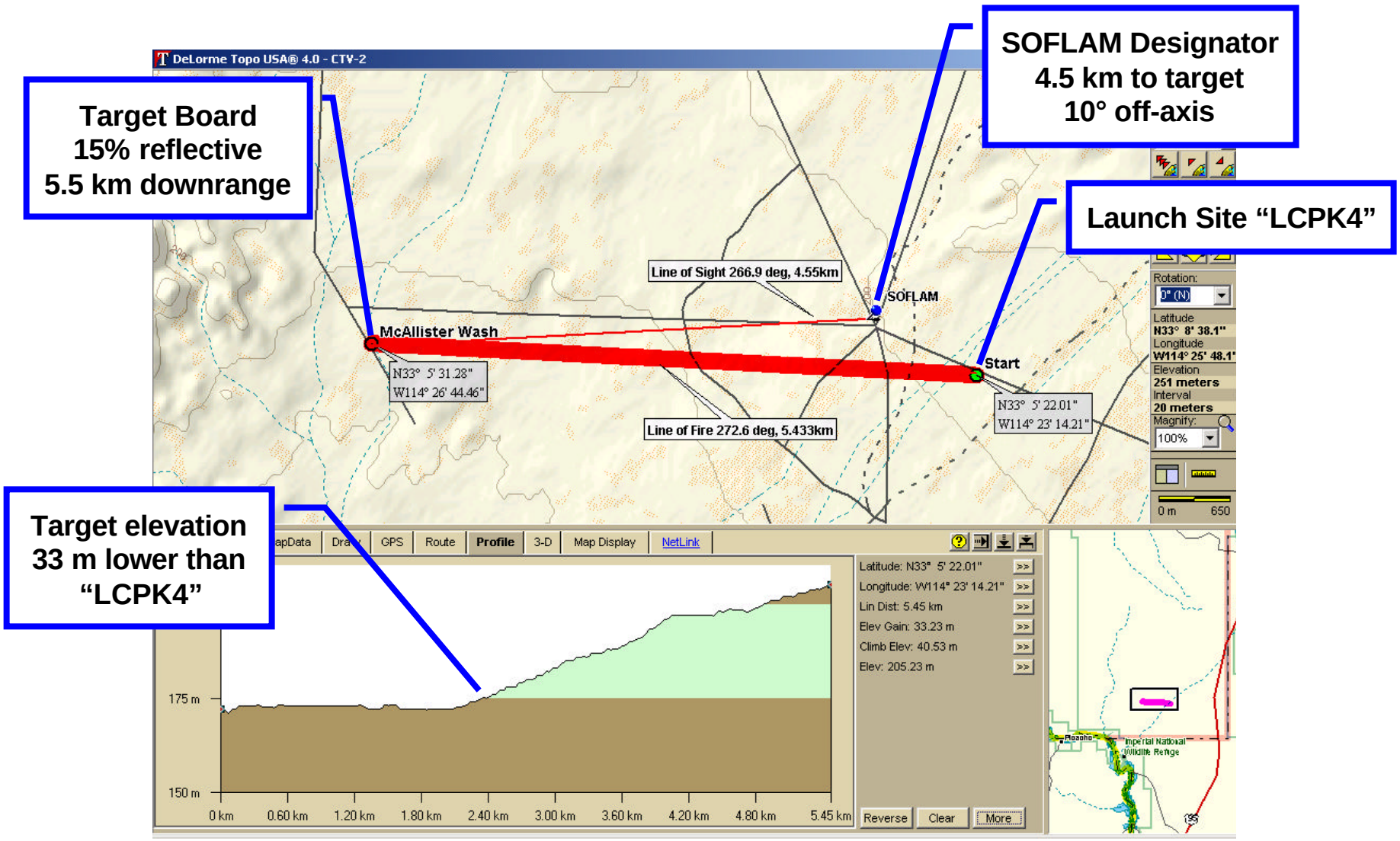
CTV Test Flight Geometry, 09/19/2002, Yuma



Impact - T+20 seconds, 5.5 km downrange

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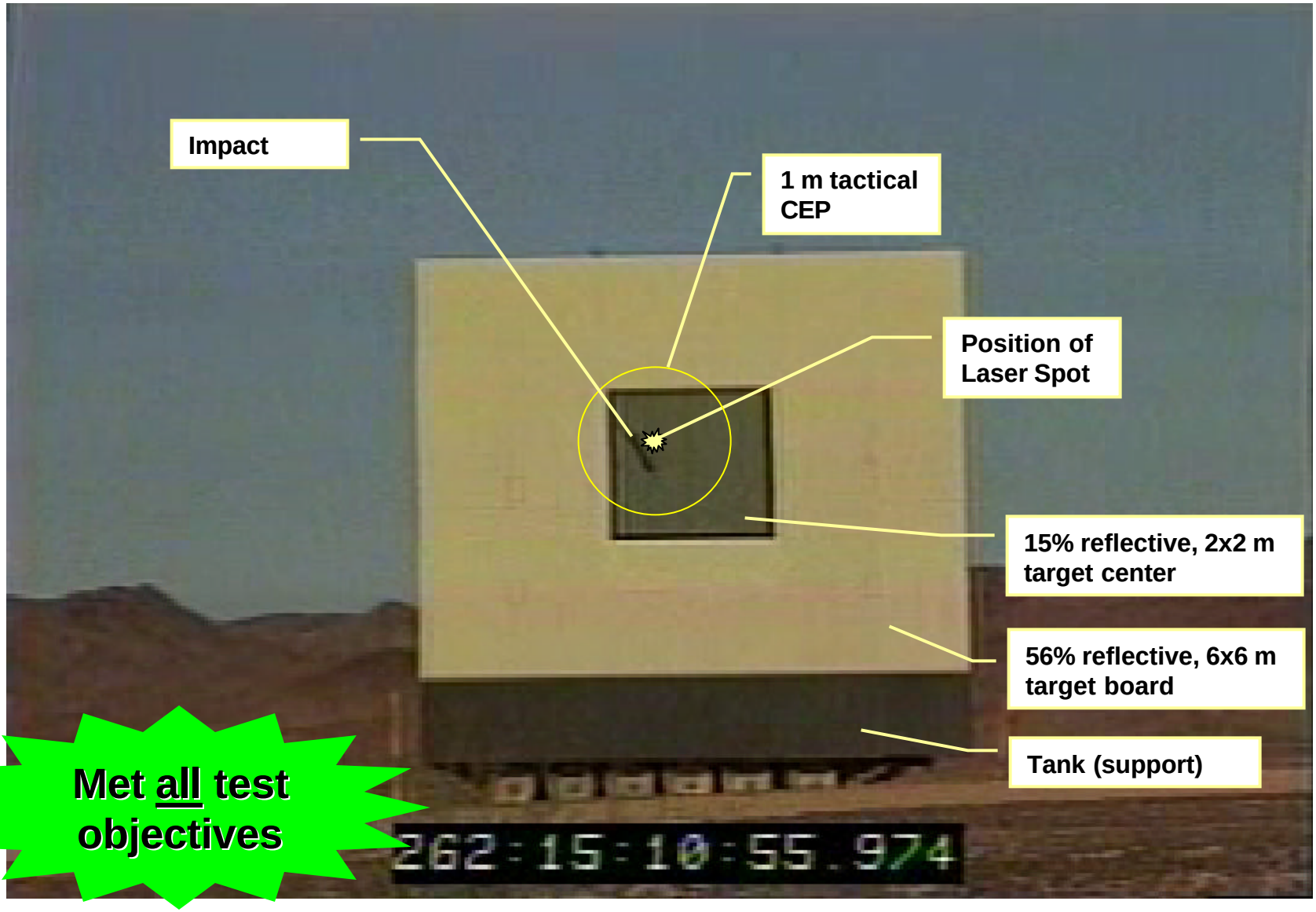

Met all test objectives

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CTV Test Flight Results

- **Target 5.5 km downrange**
  - **Center section 15% reflective — nominal low reflective paint**
  - **YPG SOFLAM laser 4.5 km from target — nominal SOF designation scenario**
  - **After completing CTV maneuvers ~12 sec, closed loop with seeker (similar to shifting target)**
  - **Hit target <1 m from laser spot — beat ATD 2 m spec**
- **Exceeded 5 km long-range ATD exit criterion**
  - **Demonstrated closed-loop control in spite of low aero energy**

High-speed tracking video (showing atmospheric turbulence, flight stability)

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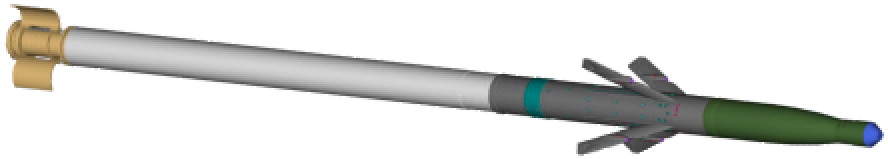
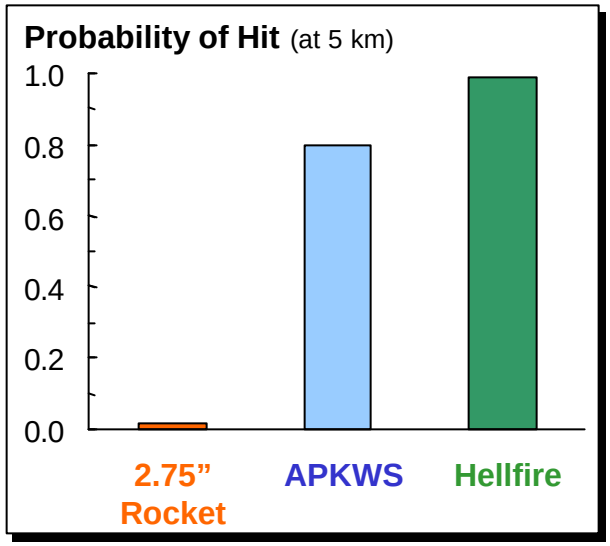
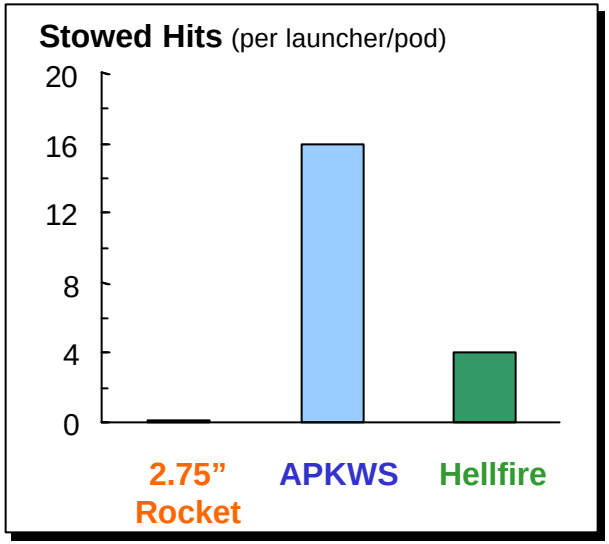
Predicted Weapon System Performance*



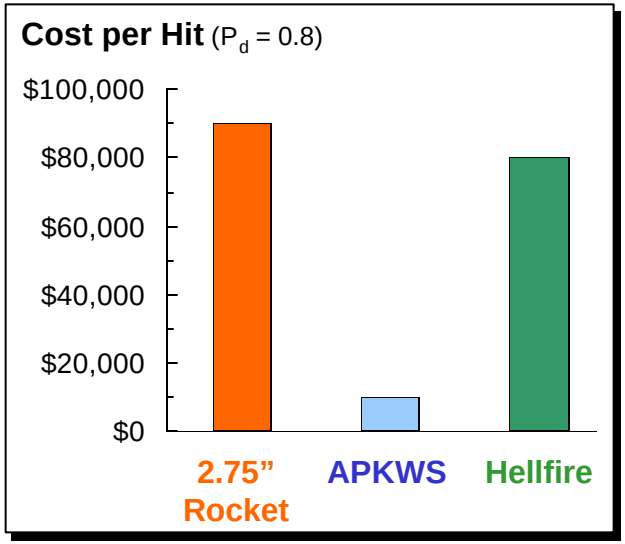
(LCPK) APKWS accuracy is comparable to Hellfire …



… providing an increase in stowed hits …



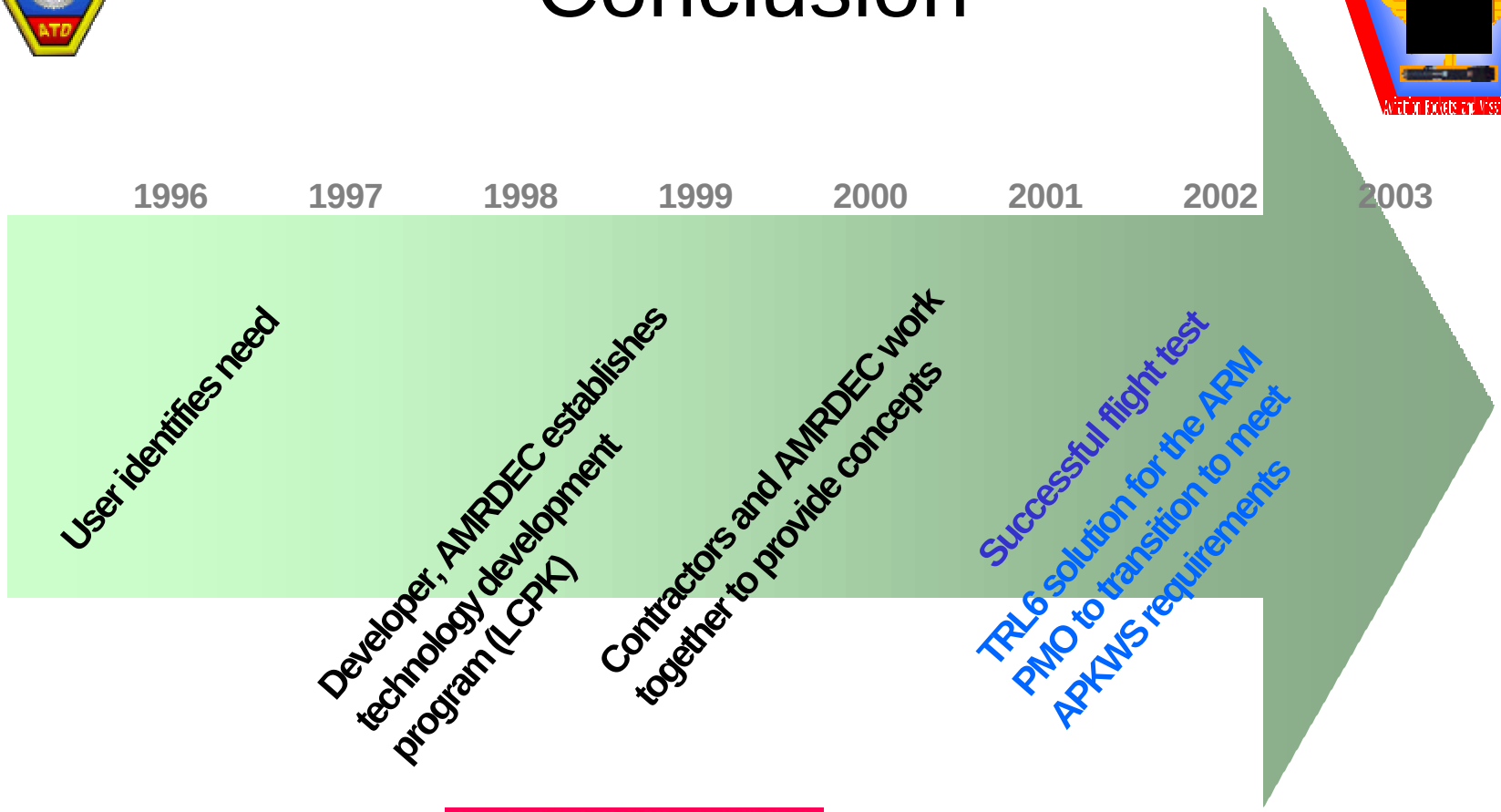
… at significantly less cost per hit.



(LCPK) APKWS provides a 4:1 increase in stowed hits at less than 1/3 the cost per hit

* Based on 6-DoF simulation

Conclusion



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